Chapter 13: DNA and its role in heredity

Exercises

Q1: Describe the main differences between purines and pyrimidines

- Pyrimidines are "single" rings; Purines are "double" rings

- There are 3 pyrimidines (C, T and U) and 2 purines (A and G)

Q2: Describe the main differences between DNA and RNA

- DNA is double stranded; **RNA is single stranded**

-DNA has a constant structure: double helix; RNA can have make conformations

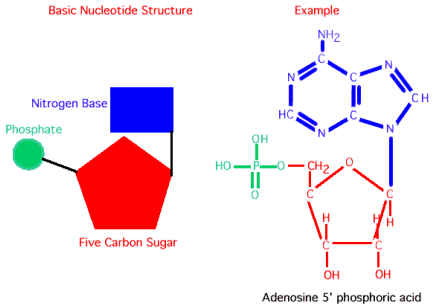
- DNA contains A,C,G and T; RNA contains A,C,G and U

- DNA contains deoxyribose; RNA contains ribose

Q3: Which of these is wrong:

1. A purine will bind to a pyrimidine
2. **DNA and RNA are composed of sugar, sulfur and bases**
3. DNA and RNA have a directionality (5' -> 3')
4. RNA is a product of DNA

Q5: Draw a schematic representation of a nucleotide



Q6: List the possible nucleotide pairings and explain why these are the only ones allowed

- A->T

- A->U

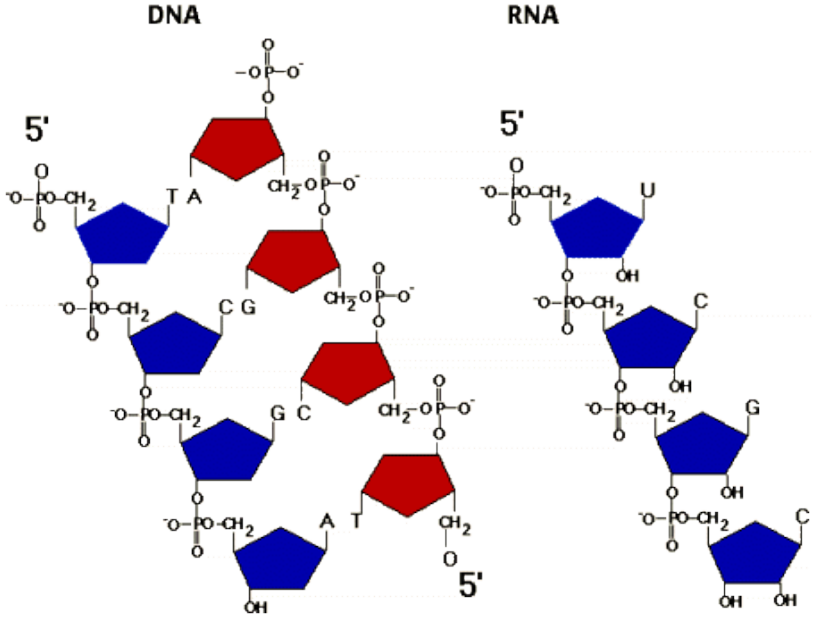
- C->G

- Number of possible hydrogen bonds (A-T; A-U 2HB; C-G 3HB)

- geometry of sugar backbone

- size of bases are complementary. "length of A-T is the same as length of C-G". Mismatched pairs will not have consistent lengths

Q7: Draw a schematic representation of an RNA and a DNA molecule



Q8: Is this statement true or false?

The distance between the DNA backbones is constant as the length of each nucleotide pair is always the same

TRUE

Q9: What are "replication", "transcription" and "translation"

- Replication: copying of a complete DNA molecule
- Transcription: copying of a gene into RNA
- Translation: creation of a protein from RNA

Q10: What statements define the "dogma of molecular biology"?

- **DNA can reproduce itself exactly**
- DNA is transcribed to RNA which is translated into proteins

Q11: How did the results from Griffith, Avery, MacLeod, McCarty and Hershey-Chase experiments confirm that DNA, and no other molecule, is the genetic material in cells?

They brought several lines of evidence such as:

- information can be passed between cells (R-S pneumococcus strains;)

- Proteins and RNA do not transfer information (destruction of proteins and RNA has no effect on S strain growth while destruction of DNA has)

- DNA is actively transferred to a host from a viral pathogen (S35 and P32 experiment with phage and bacteria)

- Therefore, it is demonstrated that the only "material" transferring genetic information is DNA.

Q12: what experimental data did Watson and Crick use to unravel the structure of DNA used?

- Franklin's crystal structure (helical molecule)
- Chargaff's rule (there's a T for every A and there's a G for every C)
- modelling studies (anytiparallel strands).

Q13: As we have explained, the "natural" direction of replication and transcription is from the 5' to the 3' end of the DNA. However, when replicating DNA, a 3'->5' synthesis is also occurring. Describe how is this achieved.

Use of multiple RNA primers, distanced by several bases. The gaP between primers is filled by "Okazaki fragments" which are normally 5'-3' extended DNA strands. These fragments go up until the previous primer. The primer is removed (hydrolised) and replaced by DNA. DNA ligase joins the new Okazaki fragment with the previous.

Q14: What are the roles of the following:

A – DNA helicase
B – Primase
C – DNA Polymerase
D - RNA Polymerase
E – Okazaki fragment

A – Unwinds DNA
B – Adds a primer to DNA
C – Generates and extends the new DNA strand
D – transcribes DNA into RNA
E – Creates a copy of the "lagging strand" in DNA replication

Q15: Taking this DNA sequence, where each color is specific for a strand:

5'-ACCGTCTAATGCGTGCCGAAAATGCTT-3'(Strand1)
3'-TGGCAGATTACGCACGGCTTTTACGAA-5'(Strand2)

- What would be the result of a replication of this sequence?

5'-**ACCGTCTAATGCGTGCCGAAAATGCTT**-3'
3'-**TGGCAGATTACGCACGGCTTTTACGAA**-5'

5'-**ACCGTCTAATGCGTGCCGAAAATGCTT**-3'
3'-**TGGCAGATTACGCACGGCTTTTACGAA**-5'

- What would be the result of the transcription of this sequence?

5′—AAGCAUUUUCGGCACGCAUUAGACGGU-3′(Strand 1)

3′-**UUCGUAAAAGCCGUGCGUAAUCUGCCA**-5′ **(Strand 2)**

Q16: While replicating the previous sequence, a wrong base was incorporated as shown

5′-ACCGTCTAATGAGTGCCGAAAATGCTT-3′
3′-TGGCAGATTACGCACGGCTTTTACGAA-5′

- which mechanisms are put in place to deal with these errors?

1) **Mismatch repair: a mechanism designed to spot mismatches and repair them. It excises the wrong base (together with a few neighbouring ones). DNA Pol I will regenerate the correct sequence**
2) **Excision repair: if a base is damaged or "does not fit", the area around that base is removed and DNA pol I recreates the correct DNA.**